

9. The archaeobotanical record of East Timor reassessed

This chapter discusses the archaeobotanical results obtained in the course of this research project. The degrees of confidence within which the plant assemblages from the six sites analysed were identified are detailed, and a reassessment is attempted of the identifications obtained by Douglas Yen, P. van Royen and H. St. John for plant suites recovered from Glover's excavated sites in East Timor.

9.1 The archaeobotanical record of East Timor

The results of the macrobotanical and phytolith analysis outlined above and the information compiled in the previous chapters suggest two initial observations. One is related to the quality of the information analysed and the other has to do with methodological aspects. They represent the most significant outcomes of this study and are discussed here and in the final chapter.

The first observation is that there is a complete absence of direct macrobotanical evidence for the use of any type of cereals dating back to the first pottery and introduced animal domesticates in East Timor (around 3800-3600 cal BP). Instead, the existing archaeobotanical record points to the presence of a diverse range of tree crops (and possibly tubers) in use throughout the Holocene and across the pottery-transition boundary. As previously noted, the total amount of charred plant remains recovered within pottery-bearing layers from square D at BCUM, including the smaller fraction between 1 and 2 millimetres in size, was fully analysed and no cereal grains were detected. This finding seems to confirm Bellwood's hypothesis that dispersal of Austronesian speakers with agricultural subsistence practices into southern Wallacea was not based on cereal crops (Bellwood 2005: 139). As we shall see, these results also seem to be in good agreement with the ones obtained by Glover, despite claims for the presence of remains of a possible *Setaria italica* seed in Uai Bobo 2 (Glover 1986:230; and see appendix 9 to this study). The dating of this single piece of evidence needs reassessment and a critique of Glover's general model for cereal introduction in East Timor is put forward below. On the other hand, within the current project the range of identified economic and edible tree crops in use during the Holocene was confirmed and extended. The implications of these

findings for the discussion of subsistence system models used by prehistoric populations in East Timor during the Holocene are also discussed.

The second observation relates to the systematic methodologies employed to recover charred plant remains, especially at BCUM. Although the preservation of these remains in the archaeological record may vary and be determined by post-depositional factors, the combined use of comprehensive flotation and wet sieving techniques proved successful in recovering significant quantities of charred plant materials (cf. Fairbairn 2005a). At this stage, it is not possible to determine whether the difference in results between the sites analysed (especially between BCUM and the other sites) had specifically to do with recovery techniques employed (more systematic and comprehensive at BCUM than at any other site), with post-depositional factors, or with both. However, Glover (1986) did recover significant amounts of charred plant remains from the sites he excavated using only dry-sieving with 3 and 6 millimetre mesh sieves, whereas many of the archaeological sites excavated by the ETAP team and later by O'Connor (where flotation and wet-or dry-sieving with 1 millimetre sieves were employed) contained virtually no plant remains. This suggests that while being highly recommended, the use of systematic techniques to recover plant remains from archaeological sites does not *per se* produce good recovery rates.

It should also be noted that the tables presented in chapter 8 clearly indicate that the most significant plant part type recovered in every assemblage analysed was wood charcoal (parts of trunks, branches and twigs), most probably used as fuel (Wilkinson and Stevens 2003:150). By comparison, the amount of charred plant remains in all other categories analysed was significantly lower. The point to make here, to which we shall return later, is that the amount of fruit, nut and tuber remains recovered at all sites were so low that they seem to be clearly beyond any partial sampling strategy. With the particular case of parenchyma fragments (which did not exceed 1 to 2 millimetres in size), the evidence suggests that only the use of comprehensive recovery methods allows building significant data with which to make meaningful interpretations regarding subsistence strategies based on plant resources.

One last note has to do with the age of deposits. Although no quantification was attempted, the comparison between the BCUM assemblage and the remaining materials within Holocene layers at other sites, and those sites with a Pleistocene occupation (especially Lene Hara and Jerimalai), suggest that the age of deposits is an additional post-depositional factor affecting preservation of plant remains. This is clearly the case with charred plant remains, which diminish considerably in older layers, although some of these layers also contained small

amounts of mineralised wood. As well as the problem of differential preservation of charred material with depth (Wilkinson and Stevens 2003:161), mineralisation often adversely affects preservation of diagnostic features that allow positive identification of plant specimens. This was the case with the few mineralised plant remains detected during this study, recovered from Pleistocene layers at Lene Hara and Jerimalai, and these were not analysed for that reason. In the following sections a discussion is given of the individual assemblages presented in chapter 8, followed by a reassessment of Glover's identified plant materials.

9.1.1 The BCUM assemblage

As pointed out in the previous chapter, a quick analysis of figures 8.4 and 8.5 reveals that large quantities of charred plant remains were recovered from most layers in square D at BCUM. This is especially true in layers 6, 9 and 12, which present the higher values, but also in the lowest layer associated with human occupation, layer 25, which contains almost 100 grams of charcoal. Most of these charred plant materials were identified as wood charcoal and were not analysed further. Nonetheless, the remaining non-woody specimens analysed revealed a diverse range of plant species in use throughout most of the site occupation span and these are discussed here.

Most of the identifications obtained conform to the existing reference collection, which was built based on plant species and families known to exist or to have existed in the research area at the time that Metzner conducted his fieldwork in East Timor in 1969/70 (Metzner 1977:xxviii). Some of these identifications are significant as they attest for the first time to the presence of specific plant species or families in the archaeological record of East Timor and the wider region. This is the case with the remains of prob. *Arecaceae* family, identified from layer 9 (with two mid-Holocene dates of 5920 – 5710 cal BP and 5612 – 5315 cal BP) to layer 25 (dated to 8590 – 8330 cal BP). It should be noted that although only one specimen preserved enough diagnostic features to be positively identified as cf. *Arenga pinnata* (also in layer 9), the remaining identifications obtained as prob. *Arecaceae* were based on comparisons with the specimen of that species present in the reference collection. Most archaeological specimens analysed under the SEM, however, had very glassy surfaces that did not allow for a perfect match (of cell size and structure) with the reference material.

Also of relevance is the fact that a few of these plant fragments identified as prob. *Arecaceae* were directly dated, thus excluding the possibility that they may have been vertically

displaced. This is the case with samples OZJ526 (6224 – 5999 cal BP), OZJ528 (5612 – 5315 cal BP), OZJ530 (7274 – 7000 cal BP) and OZJ531 (7274 – 6978 cal BP). Although these samples had not been identified when they were sent to the dating laboratory at ANSTO, enough material of each specimen was kept to allow for a positive identification using SEM.

Other plant specimens which were identified and directly dated at BCUM included two nutshell fragments of *Aleurites moluccana*, one nutshell fragment of *Cocos nucifera* and a cluster of seeds, tentatively identified as Moraceae type. The nutshell of *A. moluccana* is easy to distinguish using a low-powered bifocal microscope. As the hard nutshell of *Aleurites* preserves well in archaeological contexts, it might be expected that this particular structure will always be identified as *A. moluccana*. However, as it can be seen from the SEM images obtained, some smaller specimens which did not preserve the characteristically thicker layer of cells closer to the outer surface resemble *Borassus flabellifer* fruit/seed and could be mis-identified.

As previously discussed in chapter 7, the two AMS dates directly obtained on *A. moluccana* remains (OZJ525 and OZJ527 in layers 8 and 12, respectively) overlap at 2σ when calibrated. They both seem to be out of sequence and be the result of some vertical displacement. The largest quantities of *A. moluccana* nutshell fragments at BCUM, identified with the use of low-powered bifocal microscope only, were present within pottery-bearing layers (spits 11 and 12, in layer 6). However, remains of this species were also identified in various pre-ceramic layers, including two fragments in spit 43 (layer 20, dated to 7274 – 6978 cal BP, OZJ531) and spit 55 (layer 25, dated to 8590 – 8330 cal BP, Wk20335), respectively. Although some fragments may be the result of vertical displacement, it is clear from these ages that the remains of *A. moluccana* are not all displaced and that some represent the use of this species in early- to mid-Holocene contexts.

As to the remains of *Cocos nucifera*, the only identified nutshell fragment of this species was recovered from spit 3 (layer 2) and directly AMS dated to 141 – 24 cal BP. If we exclude the nutshell fragment recovered from spit 38 in Jerimalai (square B), identified as cf. *C. nucifera* and bracketed by a date of 6653 – 6434 cal BP and a date of 6454 – 6264 cal BP (the single piece identified as prob. *C. nucifera* from Macha Kuru 2 is above the topmost radiocarbon date and could be of a very recent age), the date for this species at BCUM is in good agreement with the evidence reported by Glover in Lie Siri and Uai Bobo 1, i.e. present in modern layers only (Glover 1986:229-230; see also appendix 9 in this study). This by no means suggests that coconut can not be of greater antiquity in Timor. As we have seen in chapter 4, remains of this

species were recovered from mid-Holocene layers in archaeological sites elsewhere in Wallacea (Mijares 2006:74, only tentatively identified) and Near Oceania (Fairbairn 2005:493). However, the archaeobotanical data so far from East Timor lean towards rather a later introduction.

The other plant specimen directly dated from BCUM was only tentatively identified as a Moraceae type. This cluster of small rounded seeds was recovered in spit 38 (layer 18) and directly dated by AMS to 7427 – 7146 cal BP. As previously noted in chapter 7, the original sample sent to ANSTO also contained remains of an unidentified fruit/seed and the two were dated together. Similar clusters of seeds, however, are present in other mid-Holocene layers in BCUM (e.g. layers 9, 12, 15 and 16). The identification of these seed remains is problematic. According to Fairbairn, a very similar type of seeds was identified in archaeological contexts from Papua New Guinea which are currently under analysis (Fairbairn pers. comm.). Although these remains have tentatively been identified as belonging to the Moraceae family (i.e. possible *Ficus* spp.), they do not match any of the existing reference material (see appendix 21) or any other *Ficus* spp. seeds so far observed. The closest match to the archaeological specimens analysed are the seeds of *Ficus carica* var. *domestica*, the common domesticated fig (see, for example, Kislev *et al.* 2006 for SEM images). However, this species is a Classical-period domesticate of the Mediterranean basin (see Zohary and Hopf 2000:159-164 for a revision of the species' status and available archaeobotanical data) and its presence in this part of the world at such an early stage seems improbable.

As to the remaining plant identifications from BCUM, and with exception of a prob. *Eucalyptus alba* or *E. urophylla* seed in spit 2 (above the most recent radiocarbon date obtained), they are all bracketed by existing radiocarbon determinations but were not dated directly. This basically means that the importance of such identifications for the discussion of plant management systems and matters of subsistence in East Timor that follows should be treated with caution, until direct AMS dates have been obtained on the archaeological specimens.

Layer 6 contained seven types of plant specimens identified to species, genus or family, including the Moraceae type seeds already described. The remaining evidence includes a fruit/seed fragment of cf. *Borassus flabellifer*, a testa fragment of prob. *Intsia bijuga*, nutshell fragments of cf. *Terminalia catappa* or. cf. *Inocarpus fagifer*, prob. *Barringtonia* spp. and *Pandanus* prob. *tectorius*, and a seed of prob. *Hibiscus tiliaceus*. As previously explained in chapter 7, despite a date of 4240 – 3910 cal BP in the bottom spit (12) of this layer (which probably marks the final pre-ceramic occupation of BCUM), all these plant remains were in

association with the oven feature excavated in layer 6. With the exception of the cf. *B. flabellifer* and prob. *H. tiliceus* remains, all other plant identifications are present in earlier layers at BCUM. The *Hibiscus* seed seems to match the specimen used as reference material. When compared with the one recovered from spit 1 in Telupunu (described below and illustrated in Appendix 28), it is noticeable that the charring process affected its general shape as well as preservation of the epidermis. As to the identification of cf. *B. flabellifer*, the visible size and arrangement of the cells suggest secure identification of this species. The specimen analysed lacks the robust aspect previously noted, more typical of *A. moluccana*, as well as the layer of more compact cells near its outer surface (the outer layer is preserved in this specimen but lacks that type of cells).

When observed under SEM, the RLS section of prob. *I. bijuga* testa is distinctive due to the presence of a conspicuous “dotted-line” of small round cells and two parallel layers of cells disposed perpendicularly to the outer surface of the seed, one on top of the other. Remains of prob. *I. bijuga* were also identified in layers 8, 9 (6224 – 5999 cal BP) and 12 (5920 – 5710 cal BP and 5612 – 5315 cal BP), suggesting that this species was present in BCUM since the mid-Holocene.

The plant specimens identified as cf. *Terminalia catappa* or. cf. *Inocarpus fagifer* are more problematic. As previously noted in chapter 6, *T. catappa* was first reported in East Timor by Pigafetta (1969, originally published in 1525) and later reported by Metzner (1977) in the area he investigated, as part of the beach vegetation. As to *I. fagifer*, although Metzner did not mention its presence, it has been reported from a mid-Holocene context at Uai Bobo 2 (Glover 1986:230), and East Timor seems to be within the species’ current distributional range (Walter and Sam 2002; Pauku 2006b). When analysed under the SEM, the exocarps of *T. catappa* and *I. fagifer* both present similarities and differences. In theory, large-sized archaeological specimens of these two species should preserve enough diagnostic features in order to distinguish them. In practical terms, however, the nutshell fragments recovered were so small that it would seem too risky to ascribe them exclusively to one or the other species. Both species present large vacuoles surrounded by cells disposed in a folded fashion; however in most cases these have a very glassy appearance. Besides the specimen reported from layer 6, similar remains were also identified in layers 9 (6224 – 5999 cal BP) and 19 (7274 – 7000 BP), suggesting an early- to mid-Holocene presence of one of these species at BCUM.

Nutshell remains of prob. *Barringtonia* spp. were identified in layers 6, 15 (6480 – 6280 cal BP) and 19 (7274 – 7000 BP). Additionally, specimens identified as prob. Lecythidaceae (i.e. they

resemble the specimens of *Barringtonia* spp. but did not contain enough diagnostic features to ascribe them to a species level) were identified in layers 9 (6224 – 5999 cal BP), 15, 17 (7160 – 6670 cal BP) and 23 (8520 – 8190 cal BP). The transverse section of the reference specimen analysed has an area of large parenchyma cells close to its outer surface. The central area is distinctive, with interwoven elongated cells disposed in semi-circles, punctuated by vacuoles and more parenchyma cells. As noted in chapter 6, Metzner (1977) only mentioned the presence of *Barringtonia* sp. in the area he investigated and did not specify which species. *B. procera*, although used for comparative purposes, has a localised distribution in PNG and remains the less likely candidate (the other possible ones being *B. edulis* and *B. asiatica*).

Pandanus prob. *tectorius* is the other species identified in layer 6. Similar nutshell remains were also identified in layers 9, 15, 19, 20, 23 and 25, spanning most of BCUM's occupation period. Although they were not quantified (as identification of most specimens was obtained based on bifocal light microscopy only, and not SEM), remains of *P. prob. tectorius* were particularly high between layers 23 and 25 (8520 – 8190 cal BP and 8590 – 8330 cal BP, respectively), corresponding to the first period of human occupation at BCUM. The identification of the specimens analysed as *Pandanus* sp. seems unproblematic due to the presence of large conspicuous secretory cavities (which form part of the rigid structure containing the seeds), surrounded by elongated folded cells. Final attribution to *P. prob. tectorius* is due to the fact that despite this being the only species within the genus reported in the area, the secretory cavities described do not entirely match the ones observed in the reference specimen analysed. In particular, they seem to be lacking the phloem, which may just not be preserved in any of the archaeological specimens.

The remaining plant identifications from BCUM were all obtained on specimens recovered from pre-pottery layers and present different types of problems. The only two parenchyma fragments identified as prob. *Dioscorea* spp. came from layer 12 (5920 – 5710 cal BP and 5612 – 5315 cal BP). It should be noted that no cell measurements were undertaken on any of the parenchyma fragments analysed (see Paz 2001:188-192 for the application of the determination system to the identification of specimens of the Dioscoreaceae family) and for that reason identifications suggested here are based on a general comparison with existing reference material. Despite that, the cells in both the archaeological specimens and the reference material seem to be of a similar size and shape. Both archaeological fragments presented angular to round cells, with very thin walls and almost no intercellular space, which conform to the Dioscoreaceae family. Both *D. alata*, *D. esculenta* and *D. hispida* were reported

by Metzner (1977) as species present in gardens in the area he investigated, and these were also observed during fieldwork in 2005 (pers. obs.). At this stage, the impossibility of ascribing the identified Dioscoreaceae specimens to any of these species renders interpretation difficult and it is not possible to assess whether they are more likely to be wild or cultivated yams.

From the same layer 12 (5920 – 5710 cal BP and 5612 – 5315 cal BP), two small nutshell fragments were identified as cf. *Pometia pinnata*. This important species of possible New Guinean origin (Yen 1996) was not reported by Metzner (1977) in the area he investigated, and neither was it observed during fieldwork in 2005 (pers. obs.). However, it seems to have been introduced into the Pacific east of New Guinea around 3000 BP (Kirch 1989:236) and may have also been translocated to the West. The identification was based on very distinctive rows of semi-quadrangular cells disposed in parallel rows, as well as the presence of larger round vacuoles in the radio-longitudinal section of the specimens analysed. The size of these semi-quadrangular cells in the reference specimen is slightly smaller than the ones noted in the two archaeological specimens analysed, which could be due to the size of the remains preserved being too small to contain perfectly matching diagnostic features.

In layer 15 (6480 – 6280 cal BP) two plant specimens were identified to different levels of confidence and the two are problematic for distinct reasons. One small fruit/seed fragment was identified as a possible Piperaceae type. This identification of the archaeological specimen was based on comparisons with the only reference material analysed within this family (*Piper betle*), which obviously limits the scope of likely candidates. The specimen recovered from BCUM did not preserve any visible distinctive cellular pattern, and this tentative identification was based on gross morphology alone. However, *P. betle* is a conspicuous species in East Timor today, planted as ground cover in permanent gardens around houses and chewed together with the stimulant *Areca catechu*. Remains of possible *Piper* sp. were also identified at Uai Bobo 1 in a layer predating 3991 – 3463 cal BP, the oldest radiocarbon age obtained for this site (Glover 1986:230).

The other plant specimen identified from this layer was a seed of cf. *Capsicum* cf. *annuum* which presents a different challenge. The level of confidence proposed is not related to the degree of preservation (good) and the morphological similarity with the modern material analysed (high, despite a difference in size), but with the fact that this genus is thought to have originated in the New World and spread beyond it only in recent centuries. Existing archaeobotanical data, together with modern plant distributions and genetic evidence suggest a centre of domestication somewhere between Mexico and northern Central America

(Pickersgill 1969, 1971; Heiser Jr. 1976). Recent research by Perry *et al.* (2007) on novel starch microfossil evidence for domesticated *Capsicum* spp. suggests that Chili peppers may have been domesticated from ca. 6000 BP in that continent. Despite this and the assumption that *Capsicum* spp. have only seen a world distribution in a post-Columbus period, direct macrobotanical evidence for *C. annuum* remains elusive.

The only two well-dated sites from which this has been reported are Tehuacan Valley, in Mexico (fruit remains dated to 6000 to 500 BP) and Ceren, in El Salvador (seeds and peduncles, in El Salvador (seeds and peduncles, dated to 1400 BP) (information in Perry *et al.* 2007:986). As remains of this species have not been reported from any archaeological context outside the New World pre-dating the 15th century, the single piece of evidence reported from BCUM should not be taken at face value without direct dating. If proven that this is in fact *cf. Capsicum cf. annuum* (or another member of the Solanaceae), it is thus wiser to interpret its presence as the result of vertical displacement or disturbance, rather than accepting its provenience without reservation.



Plates 9.1, 9.2 and 9.3: Uncharred modern specimen of *C. annuum* (lateral and ventral, left above and left below, respectively); archaeological specimen of *C. annuum* (ventral, above).

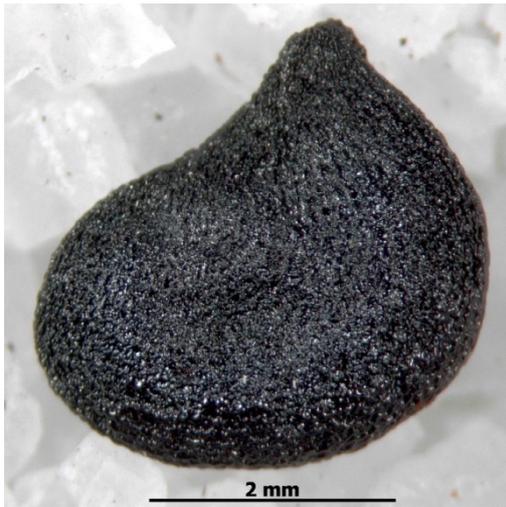


Plate 9.4: Charred modern specimen of *C. alliodora* (lateral).



Plate 9.5: Archaeological specimen of *C. alliodora* (lateral).

The remaining identified plant remains recovered from BCUM include one nutshell fragment of cf. *Cordia* elim. *subcordata* in layer 19 (7274 – 7000 cal BP) and one seed case fragment of cf. *Ziziphus mauritiana* in layer 20 (7274 – 6978 cal BP). *C. subcordata* is not listed by Metzner (1977) in the area he investigated in East Timor and was not observed during fieldwork in 2005 (pers. obs.). As this species is not known for its edible properties and only a single mention was found in Friday and Okano noting the use of its seeds as a famine food after being “carefully removed from the woody fruit” (Friday and Okano 2006:8), it was not included in the original reference collection and is not described in chapter 6. SEM images of a modern nutshell fragment were, however, obtained and those are presented in appendix 21. *C. subcordata* is a coastal species native to a wide region from the Indian Ocean to the Pacific (Friday and Okano 2006). Anaerobically preserved whole seeds of *C. subcordata* dated to ca. 3150 – 2750 BP have been reported from Telepakemalai, in the Mussau Islands (Kirch 1987:237). Remains of this species were also reported in the Apalo site in the Arawe Islands of West New Britain, dated from ca. 3800 BP to the present (Hayes 1992:68). Identification of the single specimen recovered from BCUM was based on similarities observed when comparing it with the reference specimen. The ground tissue of the nutshell analysed is mostly composed of thick-walled parenchyma cells (unlike those of *Arecaceae* and *Dioscoreaceae*) and presents vascular bundles. The cells within these bundles were preserved in the reference specimen after charring but have almost disappeared in the archaeological specimen analysed. The smaller group of cells around the vascular bundles, still visible in the archaeological specimen, has also

been fused and presents a ring-shaped glassy aspect. As the analysed specimen does not closely match the existing reference material, and the species has not been documented in the area investigated in East Timor, it has been identified within the lowest confidence to species level, i.e., cf. *Cordia elim. subcordata*.

The single fragment of cf. *Ziziphus mauritiana* from layer 20 was identified on the basis of general morphological similarities between the seed case of the archaeological specimen and that of the specimen used as reference. At the same time, analysis of the radio-longitudinal section of both fragments revealed a very similar cell structure, despite the archaeological specimen presenting a rather glassy aspect. This structure is made of small folded cells with thick walls and vacuoles. The fact that *Z. mauritiana* was reported by Metzner (1977) in areas close to BCUM and was also observed in the study area in 2005 (pers. obs.), may allow an identification as prob. *Z. mauritiana*. However, the fact that the archaeological specimen is very glassy and that various seed cases have similar morphologies recommends the identification to cf. *Z. mauritiana* only.

The list of plants discussed above comprises the total number of species, genera or families identified from BCUM. As previously noted, and as will be further discussed below, this list was compiled based on existing reference material. As the reference collection is extended in the future, many non-identified archaeological specimens may be identified to a greater level of confidence. The complete list of SEM images of all specimens analysed from this site is provided in appendix 27.

10.1.2 The Telupunu (test pit 2) assemblage

The assemblage of plant remains recovered from Telupunu had fewer identified specimens than that from BCUM, but it contained new and interesting ones not encountered in the Baucau site. Telupunu contained the only members of the Fabaceae family identified in all assemblages analysed. As noted earlier, this may have to do with the fact that a limited range of seeds from this family was utilised as reference material. Further identifications may result from a more comprehensive collection of reference specimens.

The only members of this family identified to a species level were two almost complete seeds of prob. *Erythrina* cf. *variegata*. The first was found in spit 1 (above the uppermost recorded radiocarbon date) and the second in spit 3, directly AMS dated to 800 – 680 cal BP. Compared to other members of the Fabaceae, the two archaeological specimens analysed clearly

resembled *E. variegata* in general shape and position of the hylum. Although not observed during fieldwork in 2005, this species was recorded by Metzner (1977) as growing in lowland riparian forests in the area he investigated. Despite the apparent morphological matching, however, both seeds present some distortion and one has lost considerable parts of the epidermis. The hylum is also not entire, rendering identification to species somewhat doubtful. For these reasons, it was decided to maintain the identification as prob. *Erythrina* cf. *variegata*.

Three other specimens were identified as Fabaceae types. One was recovered in spit 3, where the prob. *E. cf. variegata* was directly dated, and two were recovered in spit 4 (1174 – 962 cal BP). All three specimens seem to correspond to different species as they vary significantly in their morphology. It was this gross morphology that resulted in their classification as Fabaceae types, since they all present considerable distortion. Only one specimen preserved part of the hylum intact, and in all of them most of the epidermis is no longer preserved. The importance of these members of the Fabaceae family in the assemblages analysed is discussed below. As previously noted, additional work to extend the modern collection of reference specimens should in future allow an increase in the levels of confidence of some of these identifications.

Three other specimens were identified within pottery-bearing layers. One was a seed of prob. *Hibiscus tiliaceus*, identified in spit 1. As previously noted, this specimen is similar to the one identified in layer 6 from BCUM. However, the one found at Telupunu does not seem to be entirely charred, which probably accounts for a better preservation of morphological traits and the epidermis. The second was a nutshell fragment of prob. Lecythidaceae, identified in spit 3. As with the specimens at BCUM attributed the same degree of confidence, this specimen resembles *Barringtonia* spp. but did not contain enough diagnostic features to be identified to species level.

The third specimen, despite coming from a spit within a pre-ceramic layer, was directly dated by AMS to 3360 – 3160 cal BP, thus suggesting some minor disturbance at the pottery to pre-pottery interface. This is a small parenchyma fragment identified as prob. *Colocasia esculenta*. As noted above for the specimens identified as members of the Dioscoreaceae family, no cell measurements were undertaken on any of the parenchyma fragments analysed (see Paz 2001:178-185 for the application of the determination system to the identification of specimens of the Araceae family). However, a general comparison between the archaeological specimen and the existing reference material revealed the presence of rounded and angular parenchyma cells of similar size, with very thin walls and some intercellular space between them. One of the traits that seem to be diagnostic in this species, and which was not observed

in any of the other tuber parenchyma examined, is the presence of very distinctive vascular bundles amidst the background parenchymatous tissue (Fairbairn pers. comm.). Some of these bundles are still preserved in the reference specimen analysed, but seem to have disappeared in the archaeological specimen, leaving only a pronounced cavity inside which the inner walls are still visible. *C. esculenta* is still widely used today and was observed under cultivation in the area investigated (pers.obs. 2005). Despite not being a faithful match, the similarities observed between the archaeological and the reference specimen allows identification of the first to prob. *C. esculenta*.

The remaining identified specimens derive from pre-ceramic layers. In spit 8 (4827 – 4516 cal PB) a nutshell fragment of an Arecaeae type was identified. The cell arrangement and shape of this specimen did not match any of the existing reference material. However, the compact aspect of the ground tissue in both the transversal and the radio-longitudinal sections (despite being glassy), and the presence of distinctive secretory cavities clearly resemble the nutshell of *Cocos nucifera*. Although the identification of this specimen as elim. *C.nucifera* could be proposed, this would remain the only attribution to this species with such a low degree of confidence. For this reason, it seems wiser at this stage to ascribe identification to family level only.

In spit 11 (5069 – 4857 cal BP) a small nutshell fragment was identified as cf. Sapindaceae. As with the prob. Lecythidaceae identified in spit 3, this level of confidence results from the fact that the archaeological specimen resembles that of *Pometia pinnata* analysed as reference material, but it did not contain enough diagnostic features to be identified to species level. As noted above, *P. pinnata* was not reported in the area under investigation, hence the identification to cf. Sapindaceae only.

The last specimen identified at Telupunu was a cluster of seeds of a Moraceae type, recovered from spit 17 (6111 – 5890 cal BP and 6493 – 6302 cal BP). As previously noted for the very similar finds from BCUM, the identification of these seed remains is problematic and can only be tentatively ascribed to Moraceae type by comparison with *Ficus* spp. seeds.

The specimens described above comprise the total number of species, genera or families identified from Telupunu. The complete list of SEM images of all specimens analysed from this site is provided in appendix 28. In the following section the remaining archaeological plant assemblages analysed from East Timor are discussed.

10.1.3 Other analysed assemblages

This section discusses the plant specimens identified to different levels of confidence at Lene Hara, Macha Kuru 1 (square AA), Macha Kuru 2 (square D) and Jerimalai (squares A and B). As noted elsewhere, these sites contained fewer charred plant remains and fewer specimens were identified to species, genus or family.

In square A at Lene Hara, the only plant specimen identified was a nutshell fragment of *Aleurites moluccana*, recovered from spit 1. As noted above, the hard nutshell remains of *A. moluccana* preserve well and are usually identifiable using low-powered bifocal microscope only. This fragment is unlikely to be older than 690 – 508 cal BP, the date obtained for spit 2.

The other three identifications obtained from Lene Hara all came from square F. The first was another fragment of *A. moluccana*, recovered from spit 14, and the other two were fruit/seed fragments identified as Arecaceae type from spit 21. These two Arecaceae fragments, bracketed by mid-Holocene dates and located in pre-pottery layers, were only 1 to 2 millimetres in size and did not contain enough diagnostic features to assign identification with a higher degree of confidence. Their attribution to Arecaceae type was based on observation of cell type and arrangement in the ground tissue, which vaguely resembles that observed in the fruit/seed of *Arenga pinnata* used as reference material.

The Macha Kuru 1 (square AA) assemblage preserved the remains of two plant species which were identified using SEM. The degree of confidence ascribed to both identifications is similar to that obtained on specimens of the same species from BCUM described above. *Pandanus prob. tectorius* nutshell fragments were identified in spits 4, 12, 13, 15 and 26, bracketed by dates of 4791 – 4412 cal BP and 11,103 – 10,671 cal BP. One fruit/seed fragment in spit 15 (5584 – 5253 cal BP and 5762 – 5441 cal BP) was identified as cf. *Arenga pinnata*. As with the similar fruit/seed fragment identified at BCUM also bracketed by mid-Holocene dates, this specimen presents a very glassy cell structure. This means that the cell walls have been fused and it is not possible to measure their size. However, the specimen preserved other diagnostic features and the cell organisation is very similar to that of the *A. pinnata* seed used as reference material. Apart from the more elongated cells that form the ground tissue, it presents smaller rounder cells closer to what seems to be the outer surface; a feature also present in the reference material. Because of its glassy aspect and because the specimen analysed was too small to preserve any other diagnostic features, it has been identified to cf. *A. pinnata*.

As can be seen in table 8.14, various *Aleurites moluccana* nutshell fragments were also present at this site. However, these were only identified using low-powered bifocal microscope and no SEM images were taken, which hinders a more definitive identification. These are present in larger quantities in the first 3 top spits and in much smaller numbers from spit 4 to spit 10. Nevertheless, with the exception of the first two spits, located above the uppermost radiocarbon date of 4791 – 4412 cal BP and thus possibly of a much younger age, most *A. moluccana* remains came from pre-pottery spits with mid-Holocene ages. The same is true with the remains identified as *Pandanus* prob. *tectorius* and cf. *Arenga pinnata*, which suggests that all these species have been targeted at Macha Kuru 1 at least since the mid-Holocene. The one *Pandanus* fragment identified in spit 26 is a bit more problematic, as the date obtained is inverted and is almost 5 ky younger than the one obtained for spit 21, suggesting that some level of disturbance has occurred at the Pleistocene-Holocene boundary.

In Macha Kuru 2 (square D) the only plant specimen identified with the use of SEM was a nutshell fragment of *Cocos nucifera*, recovered from spit 2. This spit is above the topmost radiocarbon date obtained for this square of 8484 – 8344 cal BP in spit 3, although the next four dates all the way to spit 13 fall within pottery layers, and therefore the identified coconut remain could be of a much younger age. The degree of confidence suggested for this specimen is the same as that proposed for the one recovered in BCUM and identified as *C. nucifera*. Its presence in a top layer within the stratigraphic sequence at Macha Kuru 2 suggests that here too this species seems to be a late addition to the available repertoire of fruit trees.

Nutshell remains of *Aleurites moluccana*, on the other hand, were present in various quantities all the way down to spit 29. Despite the presence of some of these fragments in three layers associated with late-Pleistocene dates (spits 17, 25 and 26), square D in Macha Kuru 2 shows some degree of disturbance, with many inverted dates throughout the deposit. This disturbance could have accounted for the vertical displacement of the *A. moluccana* nutshell remains and other cultural materials. The only exception seems to be the oldest part of the deposit, with dates between 31 and 35 ky but very few plant remains were recovered within these layers and none were identified.

Square A in Jerimalai contained few non-woody plant materials and only two fragments were identified as prob. *Arecaceae*. The level of confidence for this attribution conforms to similar identifications obtained for BCUM and Telupunu, as the specimens observed presented similarities with the modern seed specimen of *Arenga pinnata*, but neither contained enough diagnostic features to be attributed to a specific genus or species. Nonetheless, these could

both be significant finds as they seem to come from Pleistocene layers of this site. Square A in Jerimalai presents one distinctive mid-Holocene phase of occupation, with 6 radiocarbon dates in the upper part of the deposit ranging from 6420 – 6245 cal BP in spit 21 to 2758 – 2696 cal BP in spit 3. Between spit 38 (16,145 – 15,308 cal BP) and spit 26 (11,242 – 10,875 cal BP) there seems to be a certain degree of mixing, and a near-basal determination further down in spit 46 returned a 43,415 – 42,146 cal BP (at 1 σ) date. One of the prob. *Arecaceae* fruit/seed fragments came from spit 34 and the other from spit 45, thus both bracketed by the above-mentioned dates.

Square B in Jerimalai held larger quantities of non-woody charred remains than square A, and more specimens were also identified. Most of these are prob. *Arecaceae* fruit/seed fragments, present in most periods of occupation of this site, from spit 60 (bracketed by the two oldest recorded radiocarbon dates of 42,372 – 41,606 cal BP in spit 66, and 41,210 – 39297 cal BP in spit 56) to spit 5 (bracketed by two mid-Holocene dates of 4897 – 4640 cal BP in spit 9, and 5453 – 5168 cal BP in spit 4). These are the oldest plant remains identified in all assemblages analysed, suggesting that a member or members of this important tree family were present in East Timor more than 40 ky ago and were possibly being targeted for their economic importance.

Other identifications within the same family obtained to a higher level of confidence included cf. *Arenga pinnata* in spit 23 (6224 – 5971 cal BP) and elim. *Cocos nucifera* in spit 38 (bracketed by two radiocarbon dates of 6653 – 6434 cal BP and 6454 – 6264 cal BP). The attribution to cf. *A. pinnata* is based on similar properties to those described for the specimens identified at BCUM and Macha Kuru 1 (square AA). Interestingly, the mid-Holocene date suggested for the Jerimalai specimen is not much older than the dates obtained for those two sites, confirming the antiquity of this species in East Timor and its probable use.

Regarding the elim. *C. nucifera*, this specimen vaguely resembles the nutshell reference material of the same species. As *C. nucifera* is present in the area under study and a reference image exists, this specimen could possibly have been identified with a higher degree of confidence, i.e. cf. *C. nucifera*. However, as it was explained regarding the *Arecaceae* remains from Telupunu that bear resemblances with the modern specimen of *C. nucifera*, the only secure matches with the reference material so far obtained all came from recent layers – including those reported by Glover (1986). For this reason, and again not excluding the possibility that coconut may be older in Timor, it seems wiser at this stage to attribute the identification a lower degree of confidence.

Finally, a small nutshell fragment was identified as cf. *Terminalia catappa* or cf. *Inocarpus fagifer*. As with the specimens identified to a similar degree of confidence in BCUM, the fragment recovered from Jerimalai was too small and did not preserve enough diagnostic features to ascribe it with certainty to one or the other species.

Before summarising the above archaeobotanical results and the importance of some of these identifications, a general reassessment of the plant identifications provided by Ian Glover is presented below.

10.1.4 Glover's charred plant materials reassessed

The results obtained in the course of investigating the BCUM and other charred plant assemblages revealed some interesting differences with Glover's identified plant assemblages and a reassessment of these was considered necessary. As previously noted, efforts were made to locate Glover's archaeobotanical material identified by Douglas Yen, but these proved unsuccessful. The reassessment presented below is thus only based on published plant identifications and the stratigraphic information provided by Glover (1972, 1979, and 1986). It should also be added that no SEM or other images were presented by Glover in support of these identifications.

The first major difference noted is the presence of cereal remains in some of Glover's excavated sites, which were completely absent (as macrobotanical evidence) at BCUM and the other sites investigated herein. *Zea mays*, the most common cereal grown in East Timor today, was only found as surface finds at Lie Siri and Uai Bobo 1 (Glover 1986: 229-230). As for *Setaria italica*, the only evidence so far reported in Timor remains the half-seed identified by D. Yen, P. van Royen and H. St. John at Uai Bobo 2 as poss. *S. italica* (Glover 1986: 230). However, this specimen was only tentatively identified and not directly radiocarbon dated. Although it was found in association with the oldest pottery at Uai Bobo 2, it was located immediately above the most recent radiocarbon determination obtained for that site (4359 – 3879 cal BP), and thus its stratigraphic position *per se* does not warrant attribution of any great antiquity. Significantly, no remains of *Oryza sativa* have yet been found in any East Timorese archaeological context, and therefore the issue of whether this species was introduced by Austronesians along with pottery and domestic animals, or much later in time, is open to debate. This issue is discussed further below.

A seed of *Coix* sp., identified as potentially *Coix lacryma-jobi*, was also found in Horizon I of Uai Bobo II in association with a radiocarbon date of 17,385 – 14,206 cal BP. Glover does not believe that this species was cultivated at such an early stage and suggested instead that it was collected as a wild plant (Glover 1979: 18). Again, no macrobotanical remains of this species were identified at any of the sites analysed within the present study. However, the phytolith record from BCUM suggests that panicoid grass morphotypes potentially associated with cf. *C. lacryma-jobi* are present from layer 19 (7274 – 7000 cal BP) to layer 5 (between 1890 – 1700 and 141 – 24 cal BP). *C. lacryma-jobi* does not seem to be a major staple today and is only referred to as a minor crop elsewhere (Arora 1977). Despite this, Lentfer commented that this species is still eaten on the Indonesian island of Flores (Lentfer pers. comm.) and suggested that it may have had, together with other grasses, some importance as a food crop in East Timor until very recently (cf. appendix 33).

As to the remaining archaeobotanical assemblage identified in the course of Glover's research in East Timor, some additional differences but also similarities with the assemblages analysed within this study were observed. As noted earlier, fragments of the endocarp of *Cocos nucifera* were only positively identified in the most recent layers of BCUM and Macha Kuru 2 and this seems to confirm the results obtained by Glover, who recovered fragments of this species only in surface layers at Lie Siri (Glover 1986: 229). Both observations suggest that the use of coconut in East Timor is relatively recent, which contrasts with older dates for its presence in the archaeological record further east (Fairbairn 2005; Fairbairn and Swadling 2005) and possibly north (Mijares 2006:74).

Glover (1979:12) commented that *Celtis* spp. were not present at any of the sites he excavated after 3000 BP. Although it could be tempting to see this as a result of deforestation caused by the introduction of more intensive agriculture, the presence of this species at BCUM within most excavated spits containing pottery suggests otherwise. This is an interesting pattern which contrasts with the one reported by Glover and elsewhere in Island Southeast Asia and Melanesia (e.g. at Pamwak, in Manus Island, hundreds of *Celtis* sp. seeds were reported from Pleistocene to mid-Holocene layers, Spriggs pers. comm.). The majority of seeds recovered from BCUM and all other sites analysed in East Timor belong to *Celtis* sp. and are not charred. Although these seeds do not seem to be a vital food source, there are accounts from elsewhere in the world suggesting they may have been used in prehistory as a food resource (van Zeist and de Roller 1995: 183). It seems likely that these *Celtis* seeds derive from wild trees that were growing near the sites investigated. However, the fact that most are found

uncharred renders it unlikely that the wood was being used as fuel, and although it needs further confirmation, the potential use of this species in East Timor as an old food resource cannot be dismissed.

Other plant remains reported from Glover's investigated sites that were not identified in the assemblages analysed within the present study include poss. *Cocculus* sp. and *Areca* sp. (presumably *A. catechu*) at Bui Ceri Uato; *Garcinia* sp., *Annona* sp. and poss. *Arachis* sp. (presumably *A. hypogaea*) at Lie Siri; poss. *Lagenaria* sp. (presumably *L. siceraria*), *Arachis* sp. (presumably *A. hypogaea*), *Bambusa* sp. and cf. *Piper* sp. (presumably *P. betle*) at Uai Bobo 1; and prob. *Bambusa* sp., poss. *Prunus* sp., *Inocarpus* sp. (presumably *I. fagifer*), a poss. Cucurbitaceae and poss. *Piper* sp. (presumably *P. betle*) at Uai Bobo 2 (Glover 1986:229-230).

To begin with, it should be noted that none of these species associated with pre-ceramic contexts were positively identified, or are firmly associated with radiometric dates (see tables 3.1 to 3.4 in appendix 9 for a complete listing of identified plant remains from Glover's excavated sites). Poss. *Inocarpus fagifer* and poss. *Piper betle* were identified in pre-pottery contexts at Uai Bobo 1. A fragment of a seed from a poss. *Arachis hypogaea* was also identified at Lie Siri. Despite being a species of presumed South American origins (Dillehay, Rossen and Netherly 1997), *A. hypogaea* was reported from two late-Holocene contexts in China (in Chang 1973:527). Based on this, Glover suggested that this species could have been introduced to Timor before the first colonial contacts (Glover 1986: 160). The impossibility of confirming the stratigraphic integrity of the Chinese sites and the lack of a positive identification in the case of the Lie Siri remains suggest caution in accepting this interpretation. They also point to the need to associate positive identifications with radiometric dating, preferably by AMS and directly on identified plant fragments.

The identifications obtained at BCU are of particular interest. Horizon VII, from where charred plant remains were identified as poss. *Cocculus* sp. (a wood fragment) and *Arecaceae* (a seed) were tentatively dated by Glover (1986:97) to the last 2500 years although the original radiocarbon sample dated yielded a modern date. The same horizon was recently re-dated in the course of Helen Selimiotis' Masters thesis and a determination on a marine shellfish sample of 8490 ± 70 (9323 – 8954 cal BP) was obtained (Selimiotis 2006:367). The poss. *Cocculus* sp. specimen could be one of the species native to this part of the world, such as *Anamirta cocculus*, a climbing plant known to have medicinal properties and be used as a fish poison (Burkill 1966:601-602). As to the *Arecaceae* seed, Glover suggests this is *A. catechu* (Glover 1986:123). The fruits of this species are widely used as a stimulant in East Timor today

and the trees are commonly planted in the area investigated. Although agreeing with Glover that this species has probably been in cultivation in Timor for a long time, it should be noted that when looked under the SEM the fruit/seed of *A. catechu* is very distinctive, with a folded cellular structure (see appendix 21 for SEM images of the modern reference specimen). *A. catechu*, however, does not possess a hard nutshell and it is possible that this may account for its absence in the assemblages analysed within this study. As other members of the Arecaceae family are also present in the area Glover investigated and it has not been possible to confirm the proposed identification, it seems reasonable at this stage to maintain this identification at a family level only.

From the same layer at BCU Glover (1986:123) reported *Aleurites moluccana* remains. As previously noted, the hard nutshell of this species is distinctive and it is possible to identify it without the use of SEM. If we are to accept both the identification proposed and its association with the new date for this Horizon at face value, then this represents the earliest date for the presence of this species in any archaeological context in East Timor.

Another assemblage which merits a more detailed comment is the one reported from Uai Bobo 1, a site excavated by Glover near Venilale, some 25 kilometres from the northern coast and BCUM (Glover 1986:127-160; see also chapter 2 of this study). Glover obtained four radiocarbon dates for this site, all within pottery-bearing layers, but rejected the lowest (of 506 – 302 cal BP, in Horizon V) and proposed a chronology for the site extending to ca. 8200 years before the present (Glover 1986:132). Amongst the plant remains reported from layers located above the topmost radiocarbon date are *Cocos nucifera*, poss. *Lagenaria siceraria*, *Zea mays* (in Horizon VIII), *Arachis hypogaea*, poss. *Areca catechu* (in Horizon VII) and poss. *Bambusa* sp. (in Horizon VI). Even if we are to accept the attribution to species proposed by Glover for all identifications and that the 506 – 302 cal BP date is in fact contaminated, it still remains the case that all these identifications are located stratigraphically above the topmost radiocarbon date obtained at Uai Bobo 1 and thus could be of a much younger age. Glover himself seems to have no problems in accepting some of these as modern introductions, such as *Z. mays*, clearly introduced after the 16th century, and *C. nucifera*.

Regarding the poss. *Lagenaria siceraria*, Yen's identification was based on the analysis of exocarp fragments (Glover 1986:230). However, identification of similar material by Yen (1977:570) from late-Pleistocene/early-Holocene layers at Spirit Cave, in Thailand, was later reassessed by Heiser who disputed that it was a bottle gourd (Heiser 1979:82-83). Prompted by a paper by Green (2000) who reassessed the presence of bottle gourd in the Pacific, Golson

(2002) revised the existing ethnographic and archaeobotanical information regarding *L. siceraria*, suggesting that an earlier find of this species in New Guinea dating to ca. 5000 BP could instead be of *Benincasa hispida*. Remains of *B. hispida* dating to 2959 – 1995 cal BP were recently reported from the Kana site in the Western Highlands Province in Papua New Guinea (Matthews 2003; Muke and Mandui 2003:184).

Despite the problems in identifying the specimens from Spirit Cave mentioned above, there is nothing necessarily suggesting that this should also be the case with the East Timor finds originally ascribed to *L. siceraria*. However, because these two species seem to have different origins, identification of the archaeological specimens with a higher degree of confidence to one or the other may have different implications. *B. hispida* is of probable Southeast Asian origins (Walters and Decker-Walters 1989; Zeven and de Wet 1982:51), while *L. siceraria* is assumed to be native to Africa (Heiser 1979, 1989). However, early archaeobotanical remains of *L. siceraria* have been reported both from Asia, in early-Holocene layers at Hemudu in China (Li 1983:48-49) and in early- to mid-Holocene sites in Japan (Crawford 1992; Imamura 1996a:108; 1996b:451; Habu *et al* 2001:13), and from late-Pleistocene and early Holocene New World contexts (Piperno *et al.* 2000; Smith 2005). Additionally, results of recent DNA work on the dispersion of this species into the Pacific prompted the suggestion for independent domestication events in both these areas (Clarke *et al.* 2006:898).

Whitaker and Carter (1954) have demonstrated that humans may not necessarily be responsible for the ancient worldwide distribution of *L. siceraria*, as the species is known to float in ocean waters for long periods of time and still germinate. While the specimens of *L. siceraria* reported by Glover may in fact be from this species or instead from *B. hispida* (or from no gourd at all), what this again suggests is that identification of archaeological plant remains based only on gross morphology is unreliable and should not be accepted at face value. A re-evaluation of these archaeological specimens should therefore be attempted if they can be located with further searching, based on comparison with modern reference materials and the use of SEM.

At Uai Bobo 1, the only plant remains that came from layers associated with radiocarbon dates are *Celtis* sp. seeds, and one seed and seed-case halves of *Piper* sp., identified as *P. betle* (Glover 1986:230). Comment on the *Celtis* sp. seeds has been made above. *Piper* is a genus with several species native to South and Southeast Asia (Zeven 1976), which today has a pan-tropical distribution. Metzner (1977) noted the presence of *Piper* spp. planted in gardens around houses in the area he investigated and *P. betle* was in fact the only attribution to

species he reported. Although reported from layers beneath the earliest radiocarbon date obtained at Uai Bobo 1 (3991 – 3463 cal BP), the suggested attribution to *P. betle* should be re-evaluated and compared to a modern reference with the use of SEM before it can be validated.

In Uai Bobo 2, located in close proximity to Uai Bobo 1, a suite of plant remains was also identified (Glover 1986:230). Comments have already been made on the remains of poss. *Setaria italica* and *Coix lacryma-jobi* found at this site. Of the other identifications not previously discussed at this or other sites Glover investigated, the fruit fragments of poss. *Inocarpus* sp. and a half seed-case of a Cucurbitaceae are the most significant. A seed of *Inocarpus* sp. was also found in Horizon XII. However, as with the identification of *S. italica* discussed above (and also remains of *Aleurites moluccana*, *Bambusa* sp. and *Prunus* sp.), it comes from layers located stratigraphically above the uppermost radiocarbon date in the Uai Bobo 2 sequence and thus could be of a much younger age. The fruit fragments of poss. *Inocarpus* sp. from Horizon V, however, are bracketed by two radiocarbon dates of 8046 – 7590 cal BP and 6414 – 6206 cal BP. As previously noted, remains of *Terminalia catappa* or cf. *Inocarpus fagifer* were identified in mid-Holocene layers at BCUM and Jerimalai B. The specimen from spit 19 at BCUM, in particular, falls within the same age range as the Uai Bobo 2 one. Despite the problems of obtaining a higher degree of confidence for the BCUM specimen and the need to confirm the identification at Uai Bobo 2 using SEM, it is tempting to view these finds as confirming the exploitation of *Inocarpus* spp. for its economical uses (food or others) at this period of time in East Timor.

As to the Cucurbitaceae half seed-case, Yen suggests that it resembles *Momordica* or pumpkin (another *Cucurbita* sp.) (Glover 1996:230). As discussed above, the identification of archaeological specimens of Cucurbitaceae (and especially *Lagenaria*) remains doubtful. *Momordica* spp. are mostly native to Africa but some are solely distributed in South and Southeast Asia (Walters & Decker-Walters 1988; Yang and Walters 1992). This is the case with *M. charantia*, the bitter melon, fruits of which are edible and eaten cooked or steamed (Ochse and van den Brink 1977:207). *Momordica* spp., however, remain even more elusive archaeobotanically (Fuller 2006:39), and at this stage it is difficult to trace the antiquity of their dispersal into Island Southeast Asia.

In conclusion, the reassessment of the available archaeobotanical information presented above suggests a complex scenario of early plant management in East Timor. Despite the taphonomic problems and variable preservation, and the fact that it was not possible to

compare the newly acquired specimens from the suites of plants analysed within this study and Glover's published material, it is clear from the above descriptions that various tree crops have been in use in East Timor since the early Holocene and possibly the late Pleistocene. As also noted, the presence of tubers (at least prob. *Colocasia esculenta* and prob. *Dioscorea* spp.) since the mid-Holocene has been demonstrated, although remains of these usually preserve poorly in the archaeological record and additional evidence is desirable. The following and final chapter discusses the information so far presented in terms of its importance for modeling the subsistence system used by human populations in East Timor in pre-European times.

